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Catch and effort relationships of the groundfish resource in Subareas 2 and 3

by

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Introduction

Comm. Doc. 75/8 contains a proposal to reduce fishing effort on groundfish in each division of Subareas 2 and 3. The present document provides background data on the catch, effort and catch per unit effort for the groundfish resource in Subareas 2 and 3.

Materials and Methods

The catch and effort data were analyzed for Subarea 2 and Division 3K separately from Divisions 3LNOP because almost all of the groundfish catch in Subarea 2 and Division 3K is composed of cod whereas in Divisions 3LNOP a broader spectrum of species is important in the groundfish catch (Fig. 2).

The basic data for catch and effort analysis were taken from the tables of basic effort statistics in ICNAF Statistical Bulletins for 1959-73 with data from 1955-58 being used in certain cases. The general approach was to combine the catch and effort data of countries in each tonnage category which had continuing and significant fisheries in this area to provide a standard catch per effort for that tonnage category. These standards formed the basic data for various general production models.

Results

Subarea 2 and Division 3K

Table 1 and Figure 1 indicate the groundfish catch by country in Subarea 2 and Division 3K whereas Table 2 and Figure 2 show the groundfish catch by major species.

Figure 3 shows catch rates of the country-tonnage categories used as standards. Although catch rates between countries are considerably different in some of the earlier years and although trends in catch rates are different for different countries over the period 1959-73 ranging all the way from an almost continuous decline in catch per day fished from 1962-73 for France (900-1800 tons) to no real trend for Poland, one

feature common to almost all countries is the decline in the catch per day fished since 1969. Some of this may have been caused by severe ice conditions in recent years but some of it must have been because of the high catches in the 1968-69 period which reduced stock size.

Figure 4 shows the catch, standard effort and catch per standard effort for two tonnage classes, 901-1800 tons and >1800 tons.. The decline in catch per effort since 1962-63 and especially since 1968-69 is evident as is the approximate doubling of the fishing effort between the early 1960's and the late 1960's and early 1970's. It is also obvious that the fishing effort has been maintained in the period after 1968 even though the catch has declined.

Since one of the complicating factors in the northern area is the change in seasonal pattern of fishing over this period from a summer-autumn fishery in the early years to a more productive winter-spring fishery in the later years, a seasonally adjusted index of abundance was also used. The basis for this was a seasonally adjusted Spanish cod catch per hour derived by J. G. Pope during his stay at the St. John's laboratory in 1974. This cod catch per hour expressed in terms of the catch per hour in March was divided into the total groundfish catch to provide seasonally adjusted standard effort figures for 1959-73. It was felt that since, as is shown in Figure 4, the cod catch represents such a large part of the groundfish catch, this was a valid standard unit of effort. The increasing effort trend and decreasing catch per unit effort trend is also obvious with this standard effort unit.

The three units of effort described above were used to construct general production curves as is shown in Figures 5 - 7. A seven year averaging period was used and all correlations of catch per effort versus average effort were significant. These yield curves generally show that the catch and effort fluctuated around MSY level during 1959-67 but were generally higher than the MSY level during 1968-73. The general conclusion is that during the 1970's there was at least enough effort to take the MSY catch and perhaps more than enough. The MSY for the groundfish resource as a whole is estimated at about 400-500 thousand tons. The sum of the 1975 TAC's is about 470 thousand tons.

Divisions 3LNOP

Table 3 and Figure 1 indicate the groundfish catch by country in Divisions 3LNOP whereas Table 4 and Figure 2 show the groundfish catch by major species.

Figure 8 shows the catch rates of the country-tonnage categories used as standards. Again catch rates between countries are different in certain years for the same category and trends in catch rates over the period are different for different countries ranging all the way from an almost continuous decline for France (901-1800 tons) to very little trend at all for Poland (>1800 tons). However, almost all country-tonnage categories exhibited a decline in catch per effort from about 1967-68 to 1973, after the period of high catches in 1967-68. This is also obvious in Figure 9 as is the fact that fishing effort increased between 1959-66 and 1967-72 and was maintained at this level even though catches declined. There is an indication of some decline in 1972-73 using 151-500 ton category and in 1973 using 901-1800 ton category but no decline using >1800 ton category.

The 151-500 ton and 901-1800 ton category standards were used to construct the general production curves of Figure 10 and 11. A six year averaging period for effort produced significant correlations of catch per day fished versus average of days fished. Both curves indicate that fishing effort was somewhat below that necessary to take MSY during 1959-66 but was at least equal to that necessary to take MSY during 1967-72 (151-500 ton standard) and may have exceeded it (901-1800 ton standard). Using the 151-500 ton standard effort in 1972-73 was less than that necessary to take MSY whereas using the 901-1800 ton standard effort was at least equal to that necessary to take MSY in 1973 and beyond it in 1972. The MSY is estimated to be about 550-600 thousand tons. The sum of the TAC's for 1975 for this area is about 560 thousand tons.

Table 1. Total groundfish catch by country, Subarea 2 and Division 3K, 1959-73.

Year	Can (M)	Can (N) Ins.	Can (N) Off.	Fra (M)	Frg	Non-Mem	Ice	Nor	Pol
1959	-	75,700	-	45,265	38,187	7,834	66,573	50	232
1960	53	64,400	3	60,607	42,777	5,811	5,077	45	-
1961	3	50,500	1	54,572	28,413	-	4,692	217	582
1962	-	68,000	-	54,686	4,835	7	2,297	-	3,263
1963	-	73,000	2	52,700	3,259	5	5,199	-	17,450
1964	-	57,400	19	57,166	13,871	19,585	2,762	-	34,493
1965	297	55,200	29	39,646	44,816	54,937	2,738	827	41,034
1966	-	60,100	57	48,867	70,474	73,191	2,936	863	49,359
1967	219	55,900	241	52,744	33,938	72,837	2,201	2,022	54,564
1968	365	65,500	7,287	64,873	55,160	-	397	8,157	102,880
1969	-	38,500	365	39,824	72,612	3,317	359	7,036	88,466
1970	-	35,100	1,070	17,743	62,415	-	-	4,145	66,506
1971	-	33,900	589	6,416	30,452	19,067	283	7,743	44,999
1972	-	24,000	371	8,838	30,292	30,699GDR	306	9,034	54,815
1973	-	24,600	739	4,153	42,115	29,987GDR	-	7,749	47,139

Table 1 (cont'd)

Year	Por	Spa	USSR	UK	Others	Total Offshore Catch	Total Inshore Catch	Total Catch
1959	34,714	30,198	91,959	2,525	6	317,543	75,700	393,243
1960	59,806	42,123	149,519	1,144	810	367,775	64,400	432,175
1961	65,089	53,345	160,671	1,652	-	369,237	50,500	419,737
1962	75,872	67,027	87,033	4,271	-	299,291	68,000	367,291
1963	103,439	65,666	45,201	706	-	293,627	73,000	366,627
1964	79,297	72,934	85,040	1,934	-	367,101	57,400	424,501
1965	85,946	69,432	72,008	14,736	-	426,446	55,200	481,646
1966	58,773	57,932	45,884	16,507	-	424,843	60,100	484,943
1967	65,737	46,541	61,494	18,307	-	410,845	55,900	466,745
1968	72,848	46,672	195,183	23,690	-	577,512	65,500	643,012
1969	79,512	45,123	204,741	3,729	2,300	547,384	38,500	585,884
1970	49,828	16,089	137,635	2,832	6,106	364,369	35,100	399,469
1971	39,786	10,503	177,776	397	2,976	340,987	33,900	374,887
1972	27,386	5,052	211,860	5,155	3,129	386,937	24,000	410,937
1973	42,249	4,188	129,180	4,683	4,819	317,001	24,600	341,601

N.B. - Some catches by some countries which reported no fishing effort in ICNAF Statistical Bulletin, Table 4, are not included in total groundfish catch.

Table 2. Catch of major groundfish species, Subarea 2 and Division 3K, 1959-73.

Year	Cod	Hadd	Red	Pla	Witch	Y-tail	G.Hal.	Rng	Total
1959	199,261	109	186,837						386,207
1960	306,327	28	129,773	16	158				436,302
1961	356,718	135	55,455	67	87		613		413,075
1962	343,573	163	19,657	61	38		481		363,973
1963	338,539	172	23,644	119	5		602		363,081
1964	364,385	30	50,154	122	2	-	2,807	-	417,500
1965	405,409	60	40,245	230	34	-	2,653	-	448,631
1966	427,641	48	32,730	238	1,092	-	5,139	-	466,888
1967	399,728	190	26,162	407	365	-	6,085	17,094	450,031
1968	607,225	9	18,881	1,023	282	-	9,447	30,657	667,524
1969	556,396	39	24,606	1,906	865	-	31,917	12,779	628,508
1970	315,999	48	21,797	12,686	15,712	1	30,788	24,299	421,330
1971	242,767	143	19,306	5,348	10,448	5	19,027	75,390	372,434
1972	309,636	32	20,033	9,121	13,258	10	25,208	24,231	401,529
1973	230,975	455	38,965	5,140	18,698	549	25,381	17,399	337,562

Table 3. Total groundfish catch by country, Divisions 3LNOP, 1959-73.

Year	Can (M)	Can (N) Ins.	Can (N) Off.	Den (F)	Fra (M)	Fr (STP)	Frg	Non-Mem	Nor
1959	26,767	124,000	42,006	7,618	17,105	7,746	9,929	2,600	4,470
1960	30,069	140,200	46,489	9,678	22,702	6,783	6,913	5,591	5,258
1961	27,410	108,600	56,624	5,526	34,226	9,700	4,617	-	3,081
1962	21,231	109,700	60,065	4,592	34,743	5,788	274	339	1,897
1963	12,325	111,500	55,916	14,003	14,600	6,877	1,593	1,299	1,831
1964	18,441	108,800	58,809	-	36,583	5,631	537	42,785	6,249
1965	15,802	100,800	76,564	9,717	35,155	6,122	9,429	16,679	29
1966	22,022	100,900	84,033	14,908	31,288	8,171	6,616	7,935	211
1967	17,516	97,900	87,763	15,539	34,982	7,750	1,005	32,200	4,037
1968	12,526	90,500	84,590	17,123	21,658	3,627	-	880	11,913
1969	15,908	104,500	102,650	18,856	11,649	3,225	-	74	53,878
1970	20,996	95,000	108,526	9,562	3,834	4,495	-	-	35,534
1971	17,857	87,500	97,929	14,227	5,782	3,570	189	7,843	18,941
1972	15,273	82,400	85,394	-	8,530	3,655	69	584GDR	6,280
1973	11,313	62,800	99,520	1,802	2,598	2,810	2,294	1,720GDR	1,542

Table 3 (cont'd)

Year	Pol	Por	Spa	USSR	UK	USA	Others	Total Offshore Catch	Total Inshore Catch	Total Catch
1959	-	45,534	68,968	25,574	2,634	16,570	3,890	281,411	124,000	405,411
1960	400	40,151	78,198	74,620	10,539	15,245	8,357	360,993	140,200	501,193
1961	2,817	49,525	96,607	81,380	8,231	16,722	134	396,599	108,600	505,199
1962	3,106	22,628	73,637	24,191	5,945	14,264	339	273,039	109,700	382,739
1963	2,908	43,502	84,695	29,923	10,789	10,470	-	290,731	111,500	402,231
1964	1,675	60,740	89,529	33,521	16,716	4,202	594	376,012	108,800	484,812
1965	3,596	34,383	114,540	65,330	19,840	772	609	408,567	100,800	509,367
1966	5,313	49,934	113,153	89,151	13,885	347	885	447,852	100,900	548,752
1967	18,037	96,506	159,172	221,888	30,056	149	-	726,600	97,900	824,500
1968	1,687	95,943	187,693	186,199	11,650	199	-	635,688	90,500	726,188
1969	1,725	78,126	158,758	122,849	1,295	76	-	569,069	104,500	673,569
1970	587	73,212	161,803	102,724	314	55	3,343	524,985	95,000	619,985
1971	3,369	81,311	168,590	134,253	4,524	-	6,441	564,826	87,500	652,326
1972	3,903	53,229	152,168	113,615	3,693	-	2,124	448,517	82,400	530,917
1973	8,480	54,753	103,198	101,105	1,329	-	3,335	395,799	62,800	458,599

N.B. - Some catches by some countries which reported no fishing effort in ICNAF Statistical Bulletin, Table 4, are not included in total groundfish catch.

Table 4. Catch of major groundfish species, Divisions 3LNOP, 1959-73.

Year	Cod	Hadd	Red	Pla	Witch	Y-tail	G.Hal.	Total
1959	279,045	34,967	59,835	(19,919)*	(2,827)*	(45)*	(772)*	397,410
1960	346,383	60,585	44,009	22,217	7,272	8	-	480,474
1961	348,572	79,386	44,345	17,874	5,823	151	143	496,294
1962	284,754	35,077	42,440	17,264	5,831	90	116	385,572
1963	310,179	14,344	44,129	25,610	3,259	143	195	397,859
1964	390,932	11,207	57,561	38,995	2,252	226	908	502,081
1965	369,578	7,983	65,926	49,492	2,087	3,129	6,055	504,250
1966	379,945	9,771	53,147	55,699	5,365	4,317	12,589	520,833
1967	581,616	11,373	79,216	59,268	8,147	2,183	13,915	755,718
1968	541,003	6,540	37,951	55,185	5,161	5,001	9,779	660,620
1969	447,981	5,321	73,288	69,276	4,406	10,564	5,660	616,496
1970	419,462	7,115	65,023	78,980	12,057	26,898	6,146	615,681
1971	409,622	5,034	81,695	75,141	22,844	37,681	5,583	637,600
1972	321,157	3,575	71,087	66,301	15,932	39,671	4,894	522,617
1973	268,201	1,874	60,462	67,792	15,412	33,749	3,781	451,271

*Estimated from Subarea 3 totals.

Fig. 1. Nominal catches of total groundfish by country, 1959 – 1973.

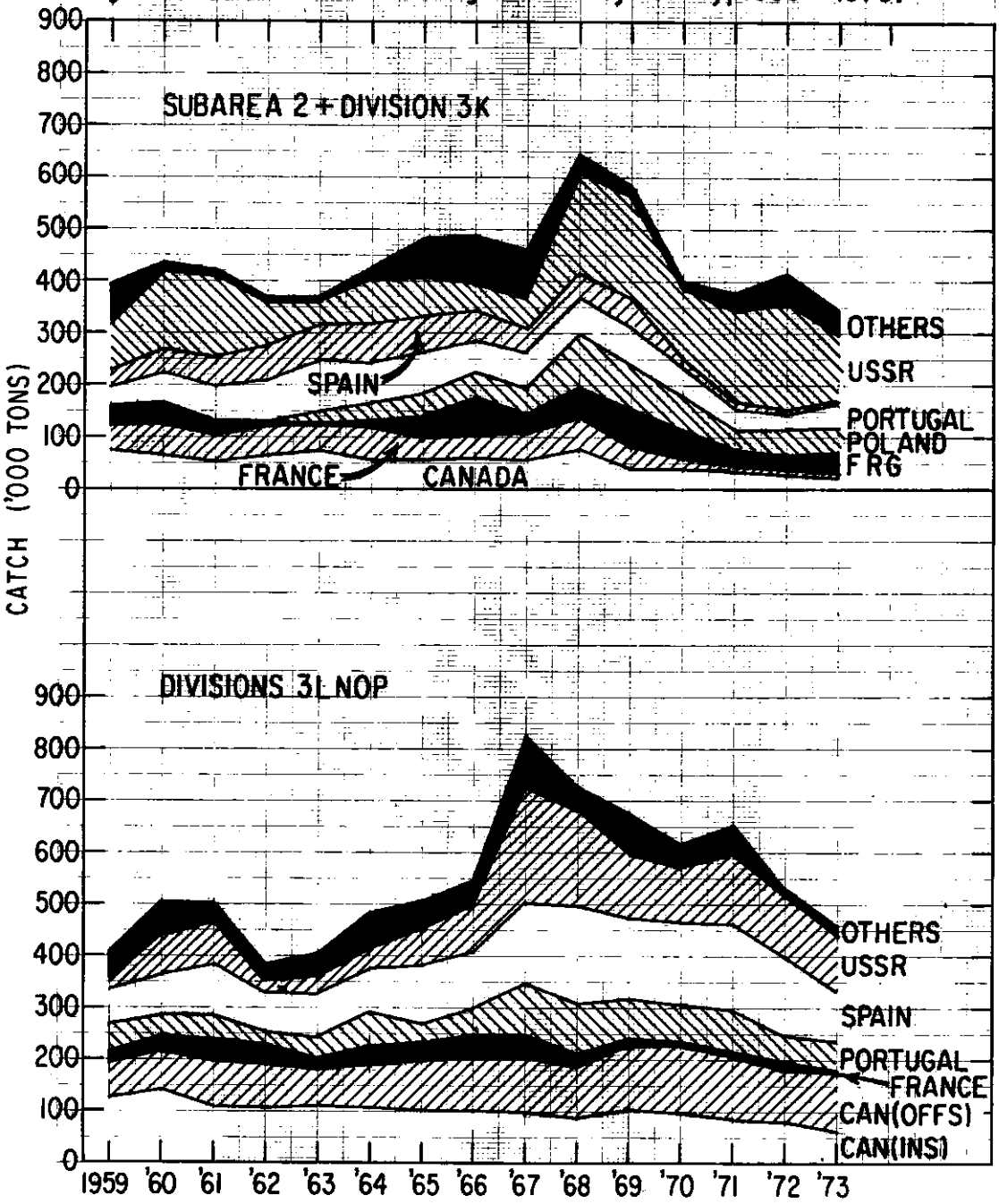
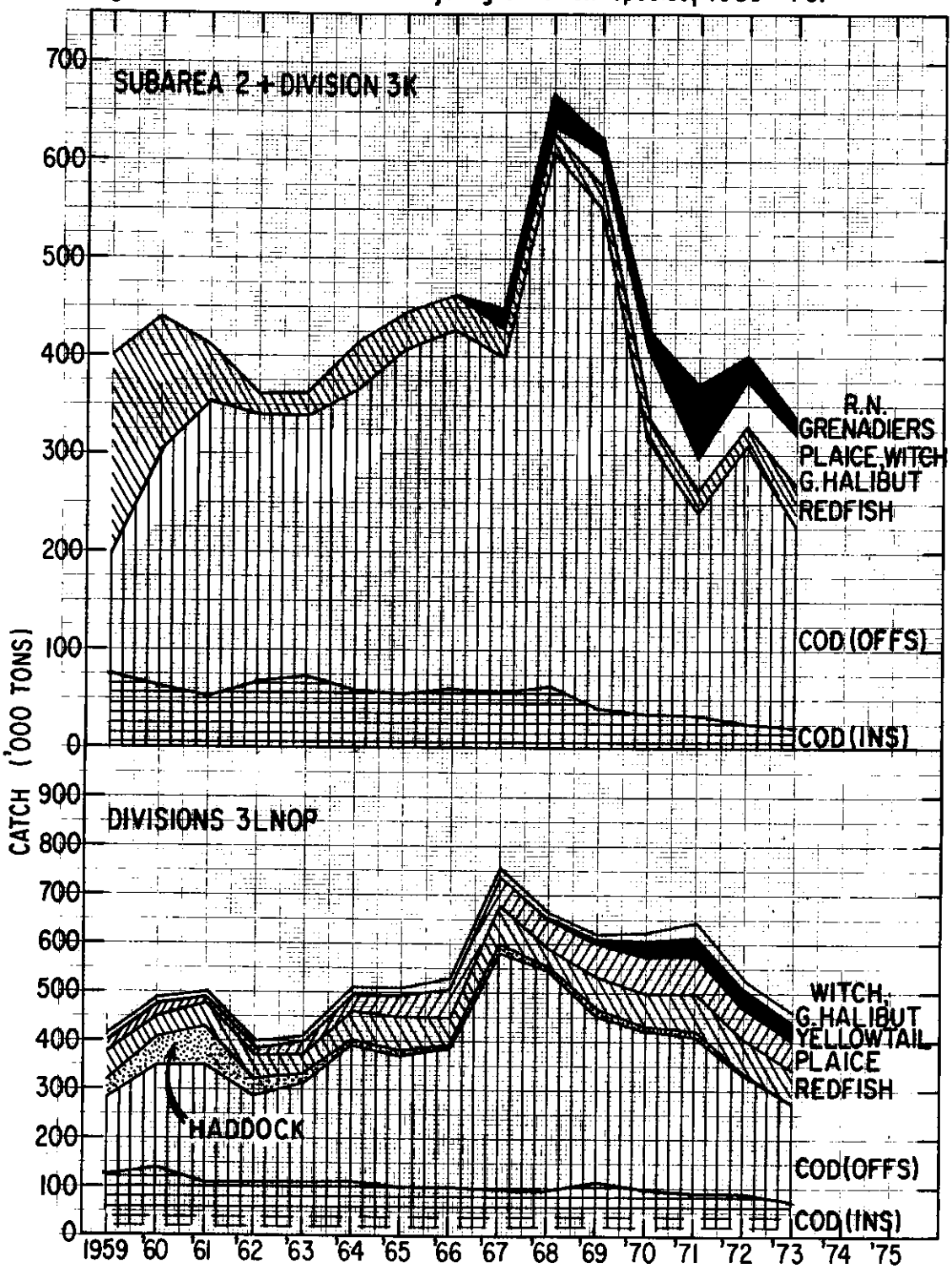


Fig. 2. Nominal catches of major groundfish species, 1959–73.



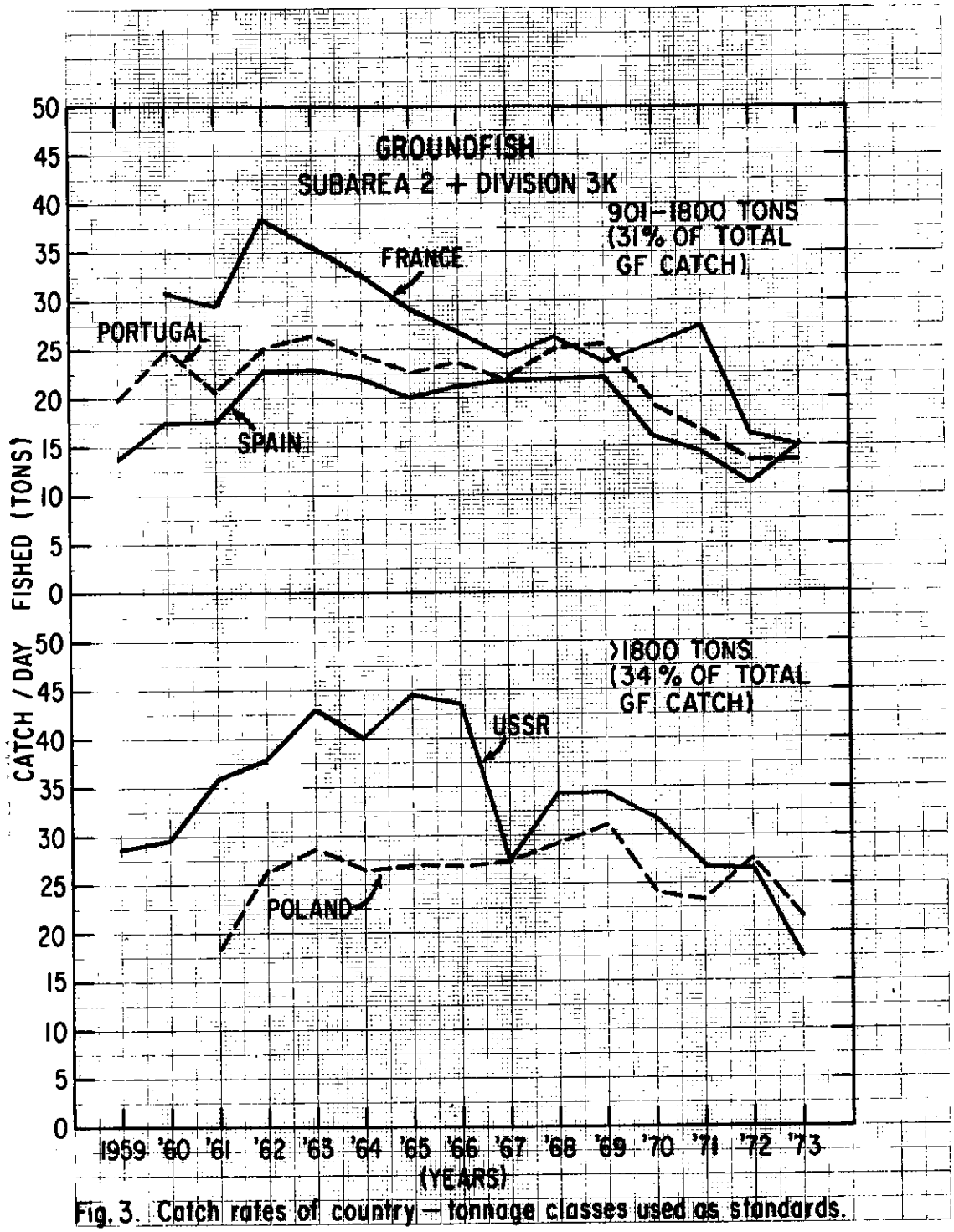
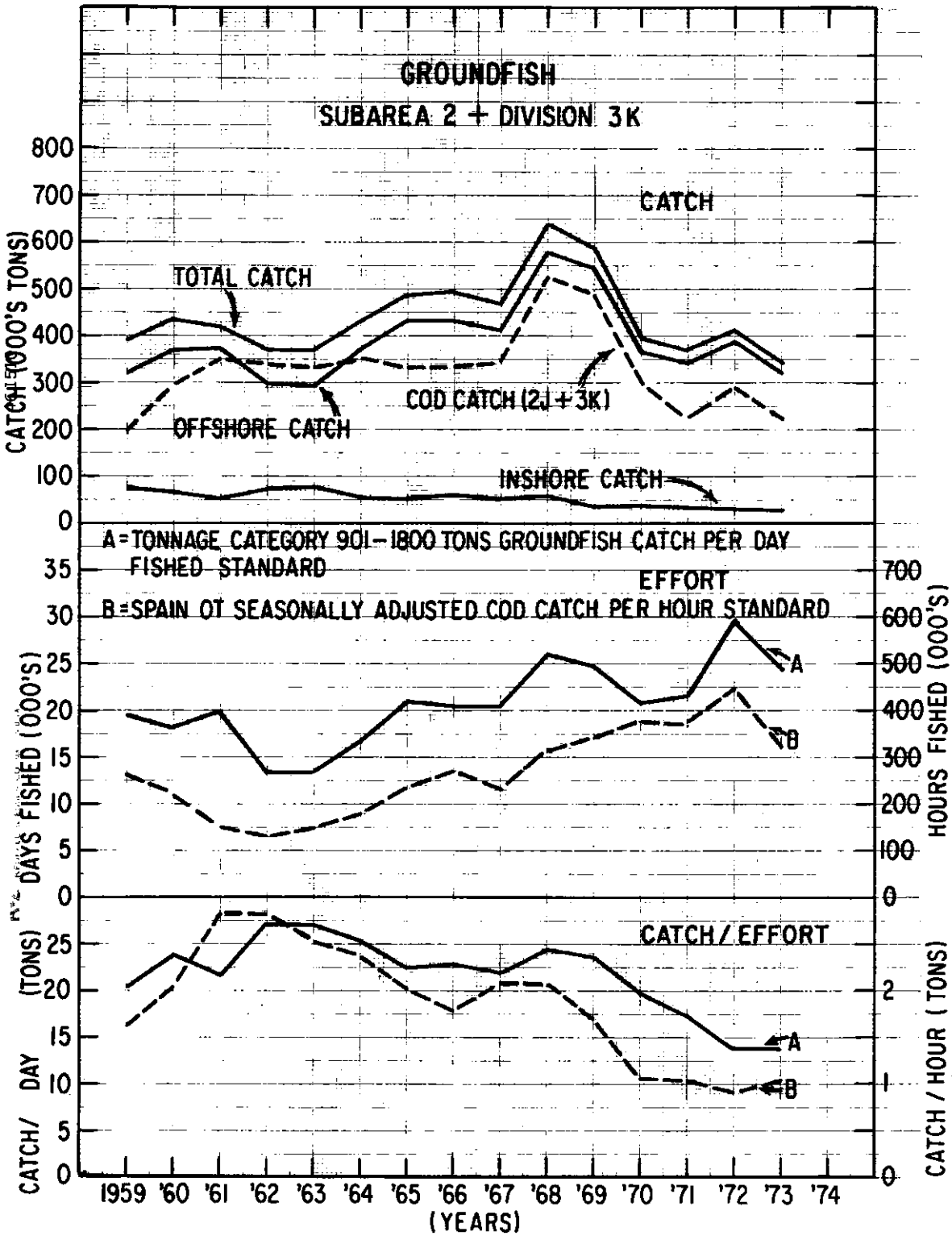


Fig. 3. Catch rates of country – tonnage classes used as standards.

Fig. 4. Catch, Effort, Catch/Effort of Groundfish in Subarea 2 + Division 3K, 1959 – 1973



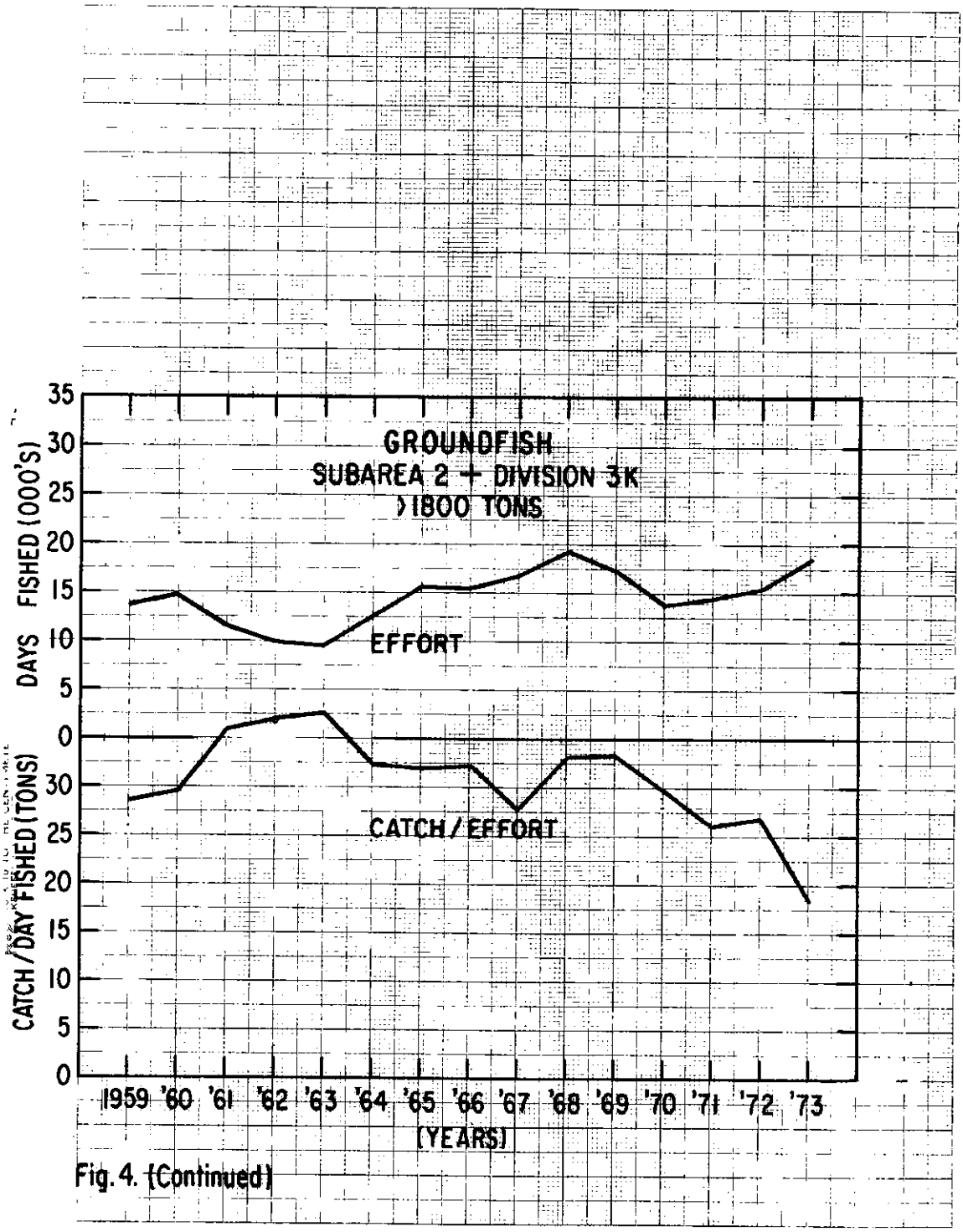


Fig. 4. (Continued)

Fig. 5. Yield curves for total groundfish resource.

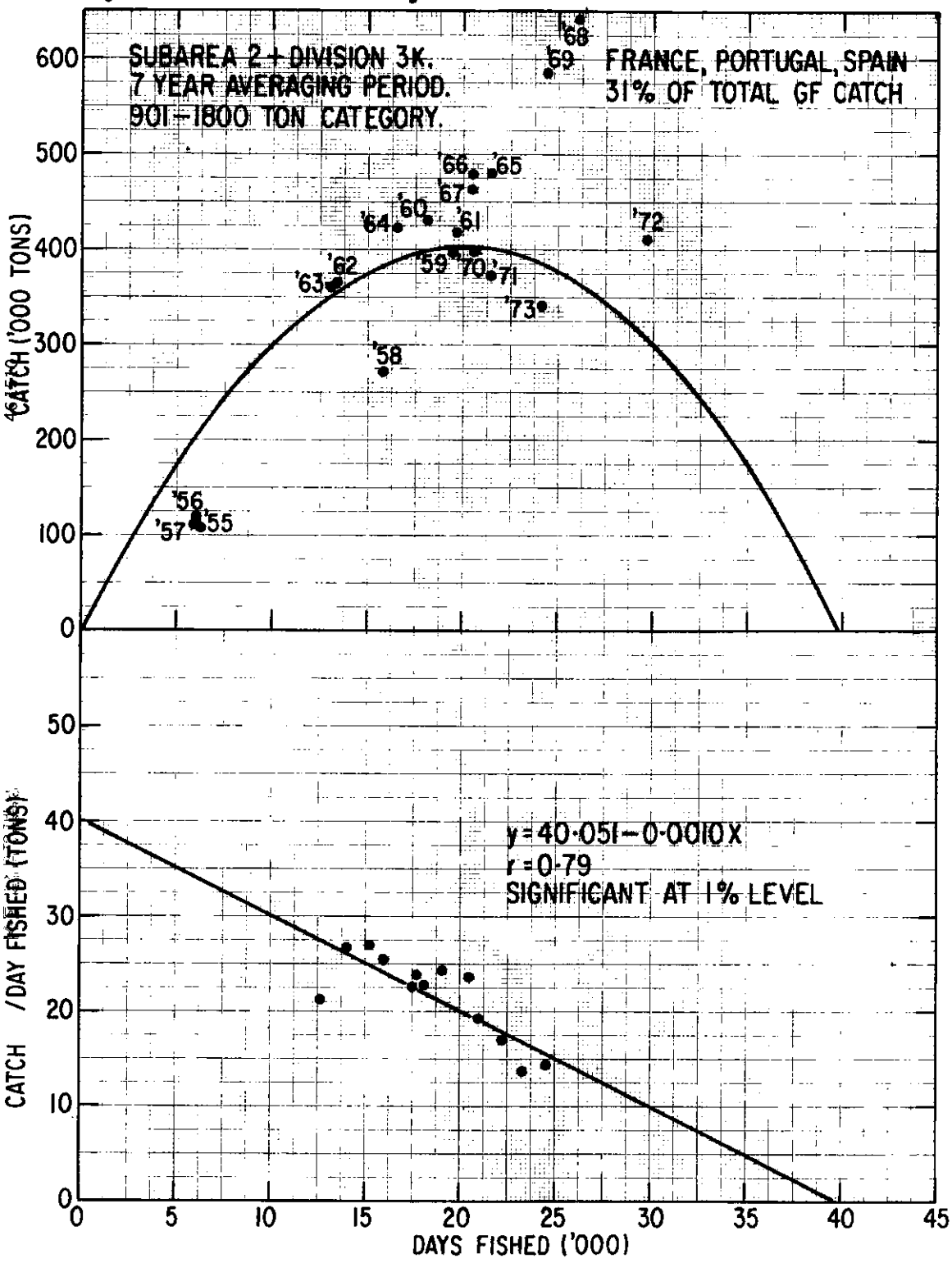


Fig. 6. Yield curves for total groundfish resource.

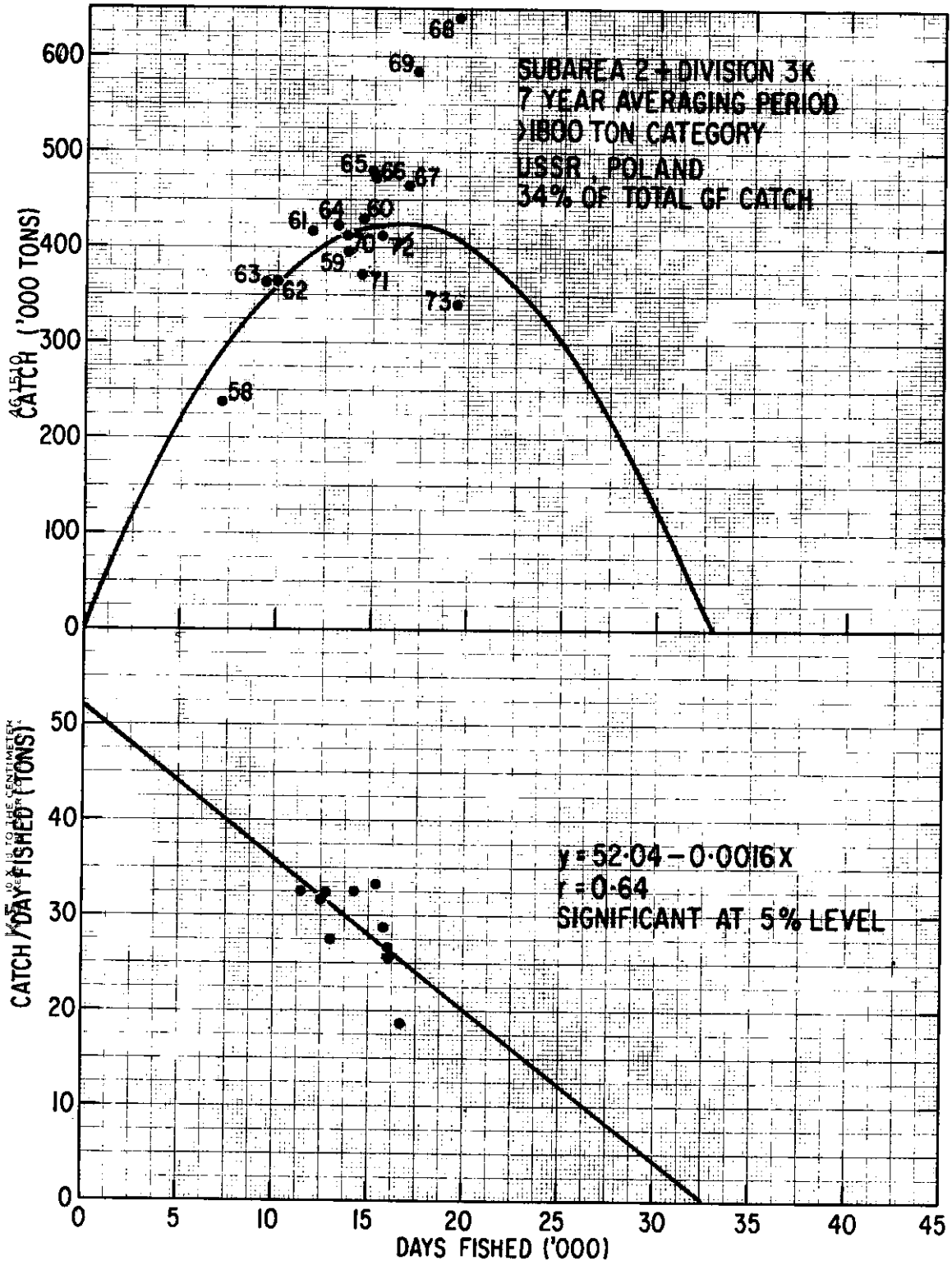


Fig. 7. Yield curves for total groundfish resource.

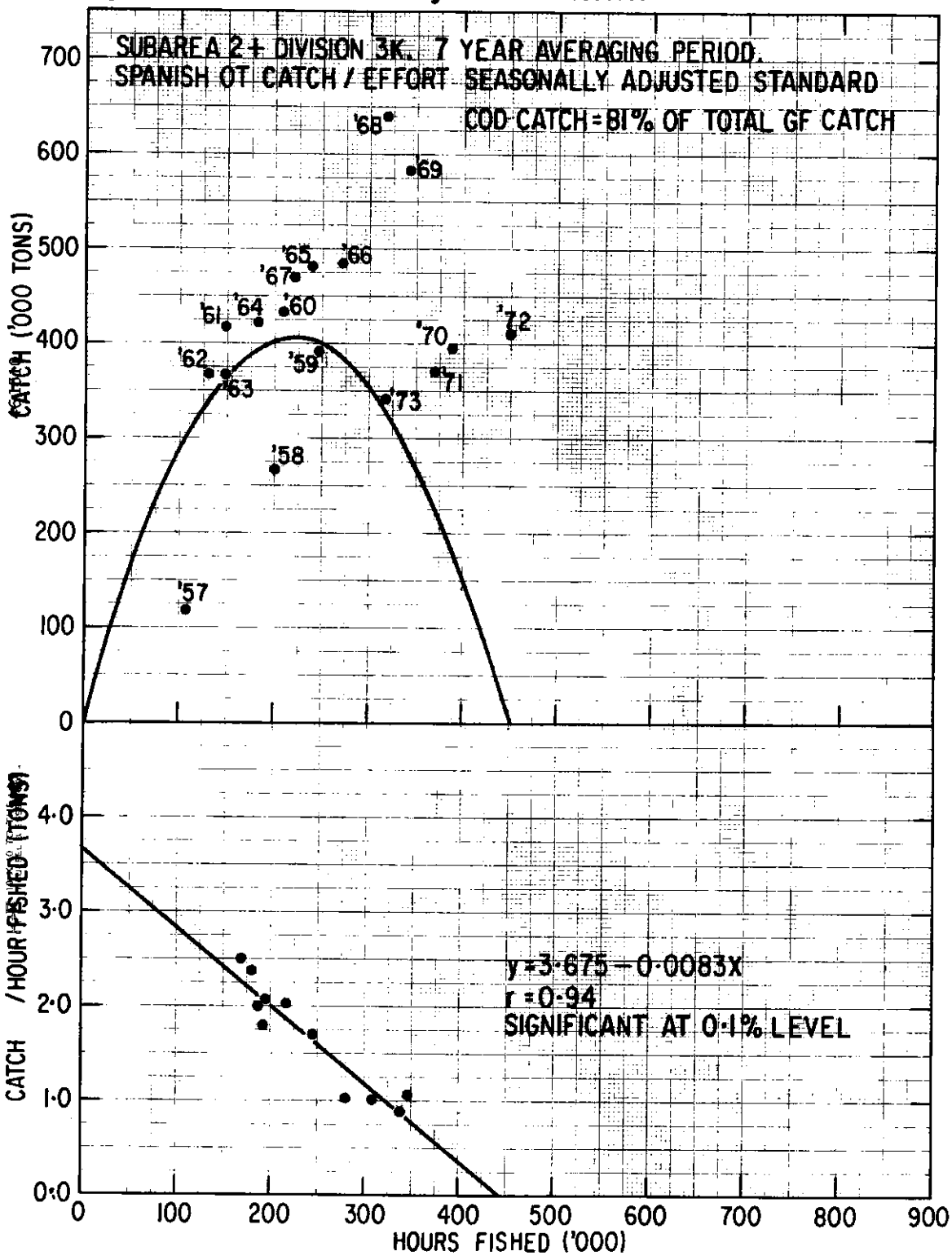


Fig. 8. Catch rates of country — tonnage classes used as standards.

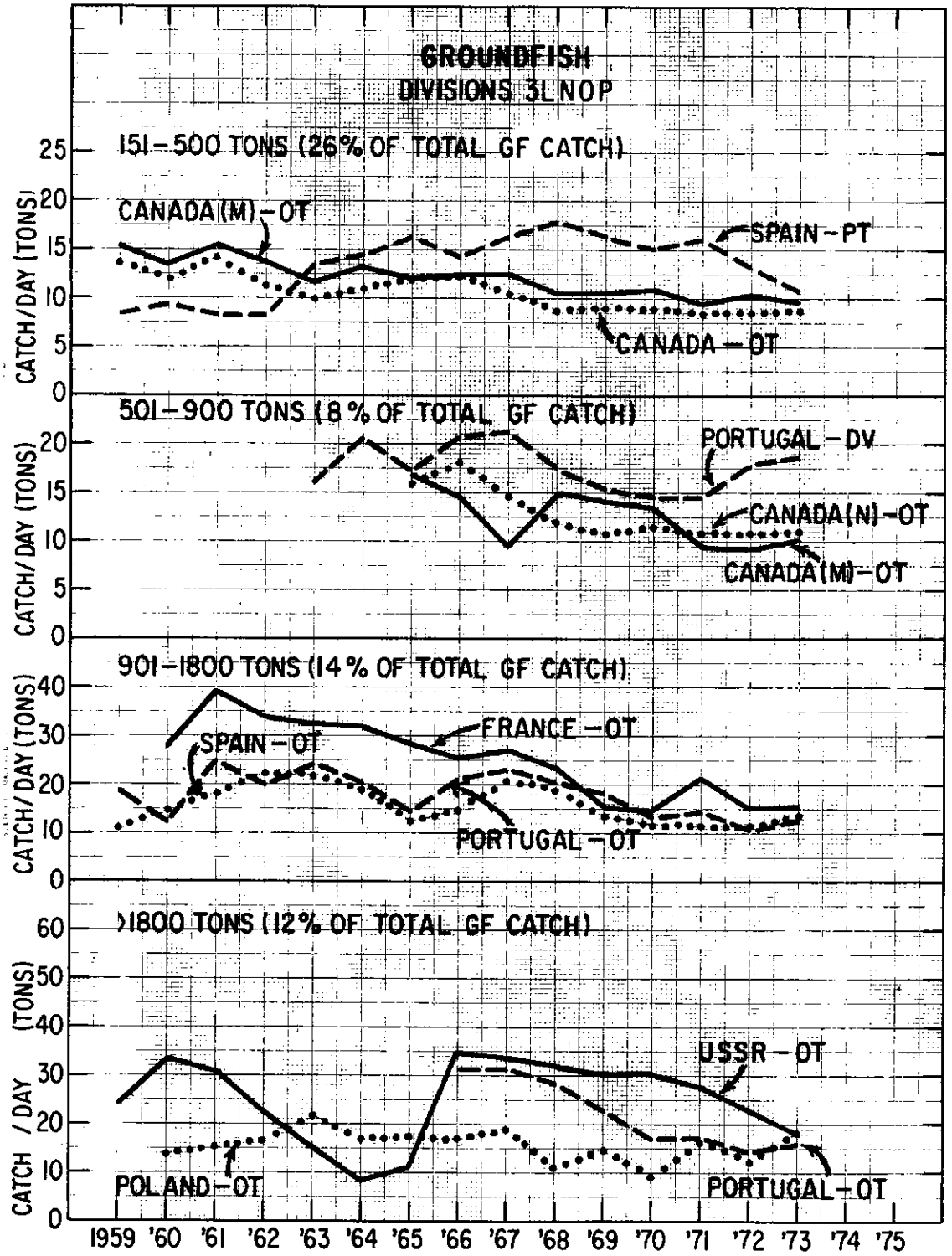
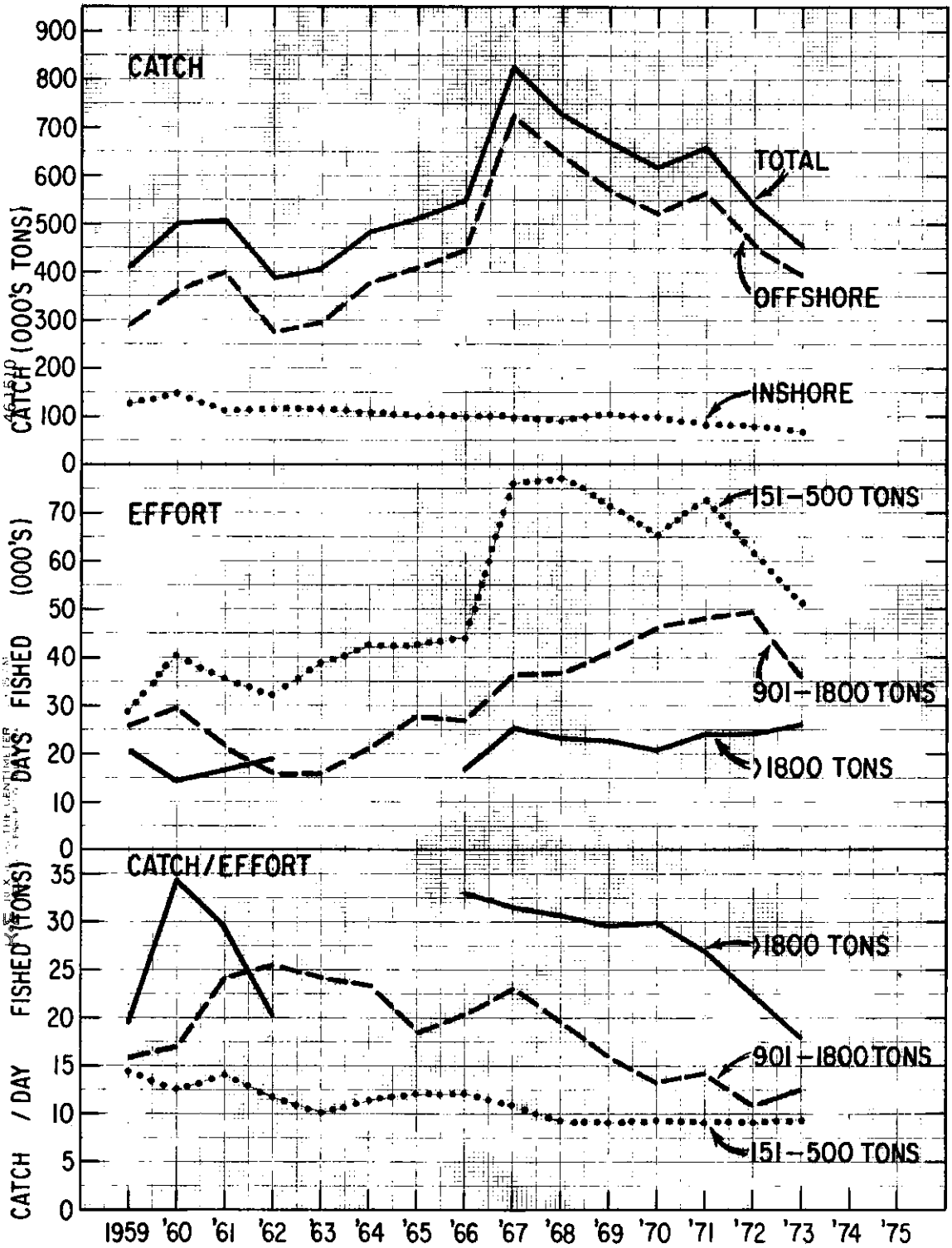


Fig. 9. Catch, Effort, Catch/Effort of Groundfish in Divisions 3LNOP, 1959–1973



E 2

Fig. 10. Yield curves for total groundfish resource.

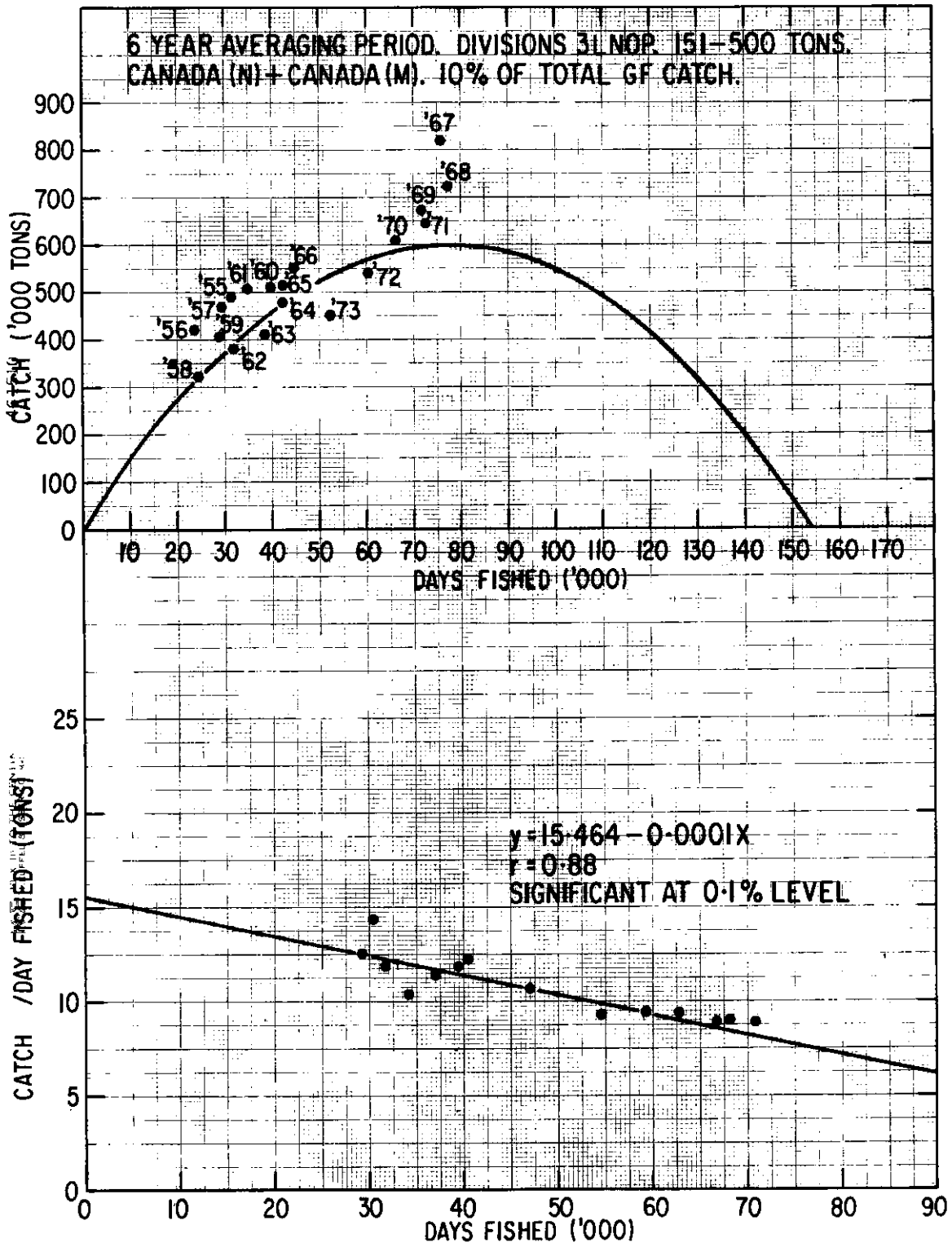
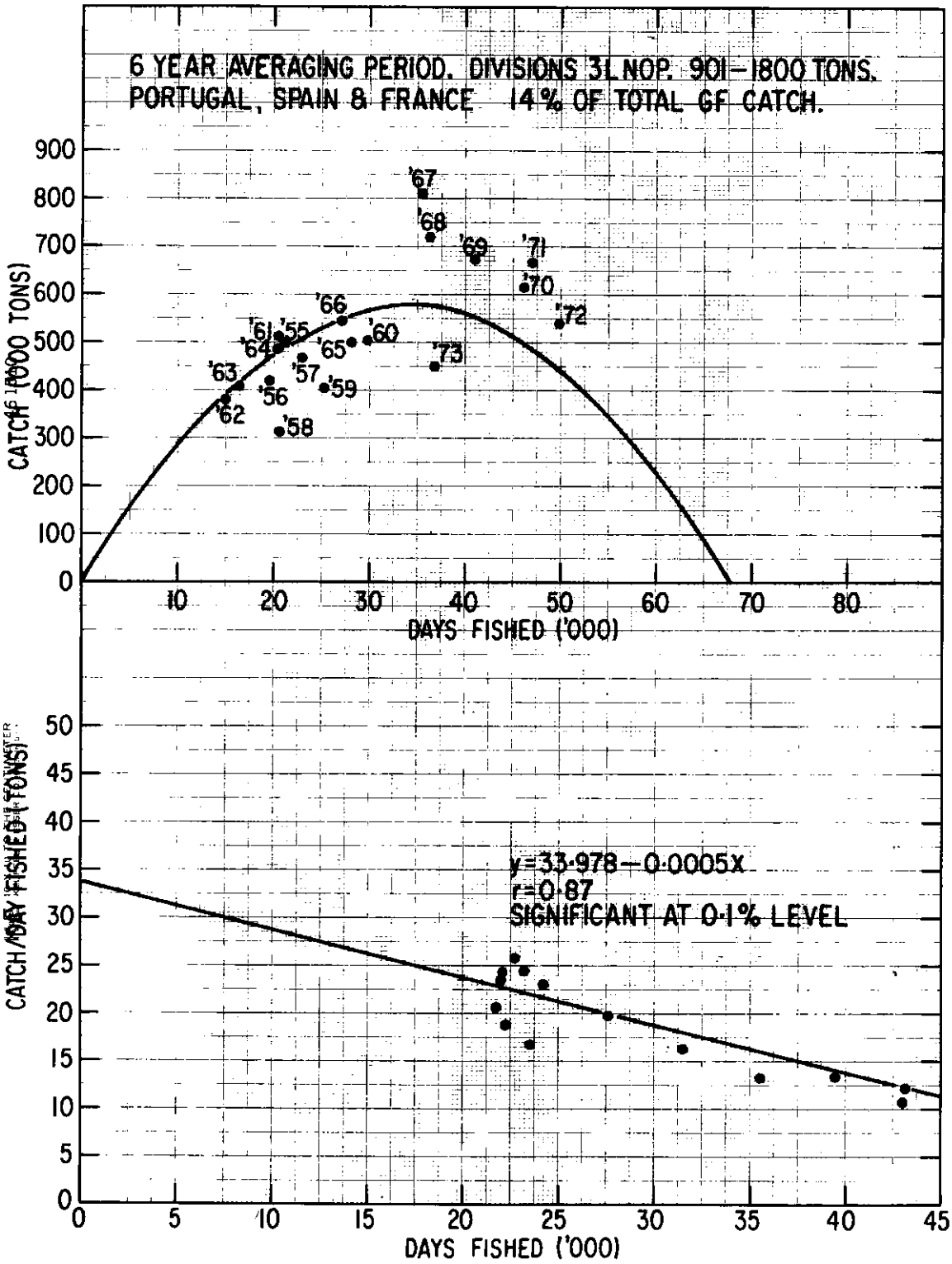


Fig. 11. Yield curves for total groundfish resource.



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Addendum I

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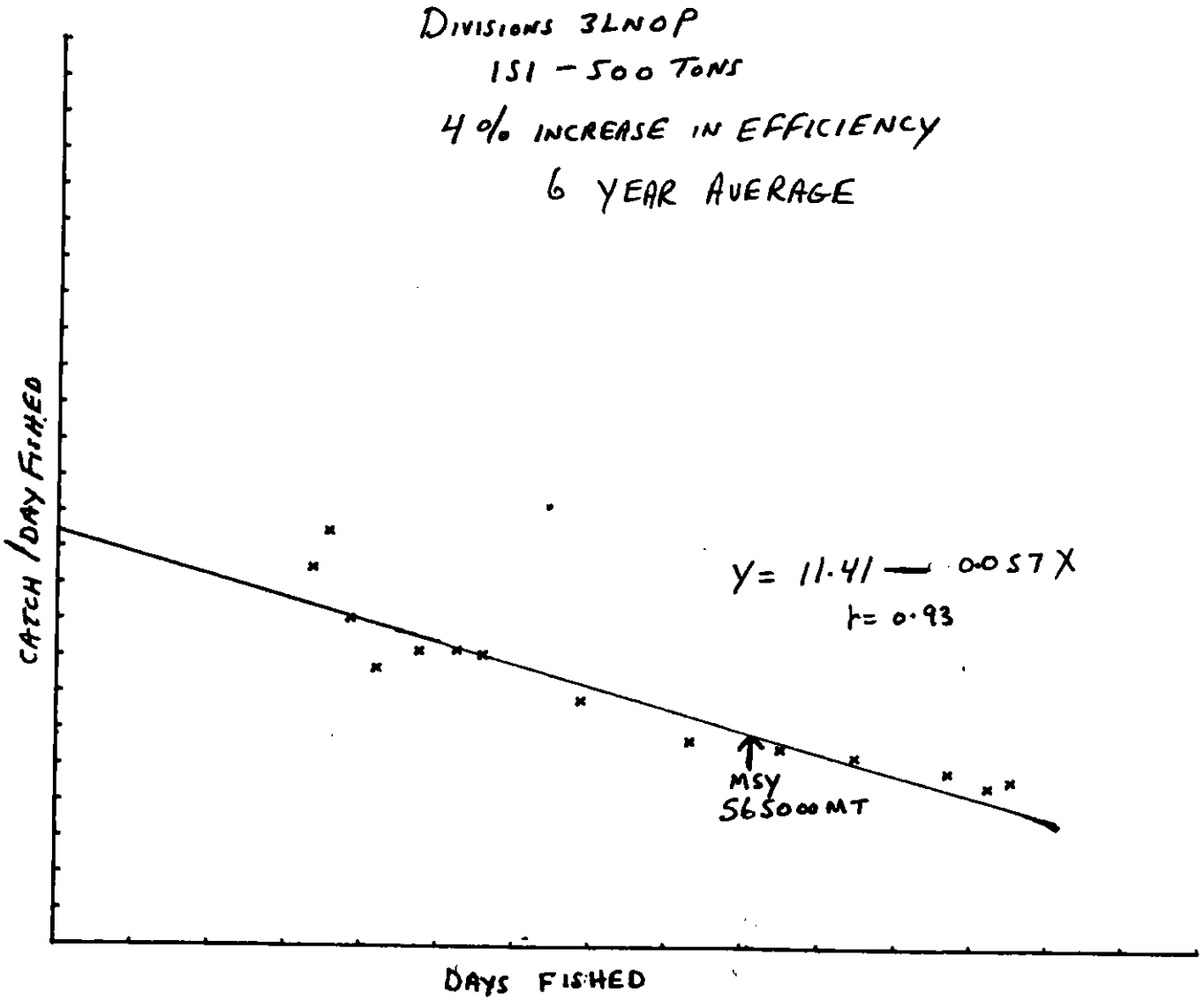


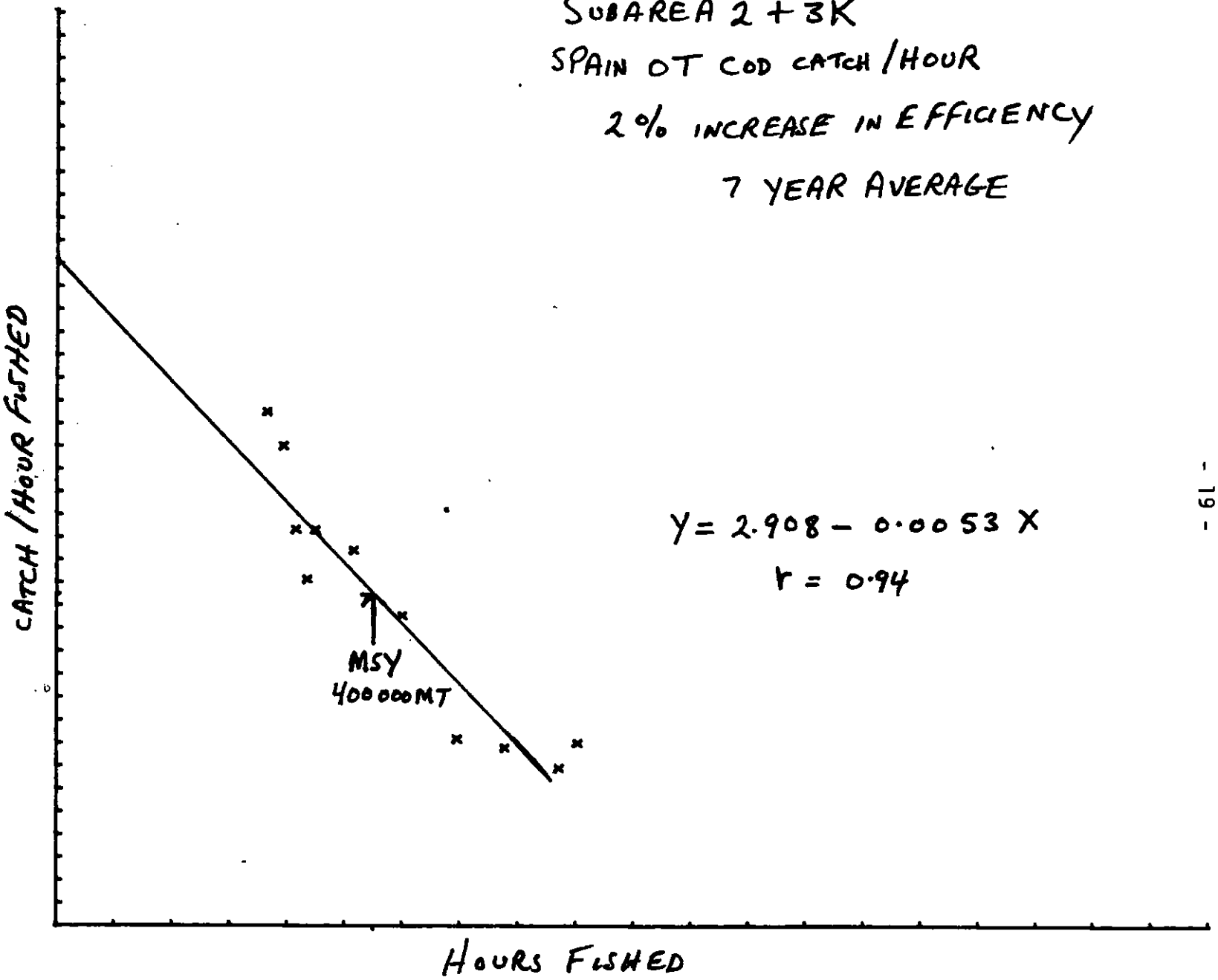
ADDENDUM RES Dec 2/75/SS

SUBAREA 2 + 3K

SPAIN OT COD CATCH / HOUR

2% INCREASE IN EFFICIENCY

7 YEAR AVERAGE



$Y = 2.908 - 0.0053\ X$

$r = 0.94$

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In Figures 5 - 7 and Figures 10 - 11, yield curves for various effort standards were shown for Subarea 2 and Division 3K and Divisions 3LNO, respectively. The curves for Subarea 2 and Division 3K used a period of 7 years to account for the lag time whereas those for Divisions 3LNOP used a period of 6 years to account for the lag time.

These curves did not take into consideration the increases in efficiency which must have occurred in the 1955-56 to 1973 period due to increases in size and power of vessels within tonnage categories, gear and navigational and acoustic equipment improvements and improvements in vessel design. To allow for these changes a steady rate of increase in efficiency was introduced into the model. Running averages of effort were varied commencing at 1 year and increases in efficiency commencing at 0% until the combination of running average and increase in efficiency which produced the highest correlation coefficient was obtained for each effort standard. These are indicated in Table 5. The results of two of these standards with efficiency increase built in are plotted in Figures 12 and 13. The general effect of these efficiency increases was to shift the effort in recent years beyond the MSY level of effort in each case.

Conclusions

The Schaefer production model indicated that the MSY in Subarea 2 and Division 3K is unlikely to be greater than 400,000 tons and is probably less than this. The lowest estimate of MSY was 375,000 tons. The estimated MSY for Divisions 3LNOP is unlikely to be greater than 600,000 tons and could be as low as 525,000 tons. Table 5 indicates that for all of the fishing effort standards used, the effort adjusted for increases in efficiency has been beyond that necessary to generate the MSY catch in every year in the 1967-73 period except in the case of the Spain otter trawl standard in Subarea 2 and Division 3K in 1967 and the 151-500 ton standard in Divisions 3LNOP in 1973. In Subarea 2 and Division 3K, fishing effort in 1973 could have been 30-60% above the level necessary to attain the MSY catch whereas in Divisions 3LNOP the effort in 1973 was at least high enough to attain this level and could have been 25% above it. Some of the apparent reduction in groundfish effort in 1973 for both areas probably resulted from a diversion of groundfish effort to fishing for capelin this year.

Groundfish catch quotas for Subareas 2 and 3 set for 1975 sum to 1,089,000 tons. In addition, some 30,000 tons of unregulated groundfish can be expected to be caught in 1975 indicating a total catch of 1,119,000 tons if all TAC's are caught. Bearing in mind that some increase in efficiency certainly has occurred, the groundfish MSY for Subareas 2 and 3 is unlikely to be greater than 1,000,000 tons and is probably less than this; the lowest estimate for the Schaefer model is 900,000 tons.

Preliminary 1974 data on catch rates of Newfoundland-based bottom otter trawlers indicate a decline in catch rate between 1969 and 1973 of 14% and a decline of 19% between 1973 and 1974 for a total decline of 30% between 1969 and 1974. This indicates a continuing decline in population abundance.

Catch quota regulations in force in 1975 for Subareas 2 and 3 are not sufficient to prevent continuing stock decline. A reduction in fishing effort of 30 - 40 % may be necessary in Subareas 2 and 3 as a whole to even reduce fishing effort to the MSY level especially since in both areas the fishing effort now on capelin is capable of being diverted back to groundfish with any improvement in catching prospects due to increased recruitment and/or availability.

Table 5. Groundfish MSY catch and effort from combinations of averaging periods and increases in efficiency producing best correlations of CPUE versus effort. Adjusted effort for each of the years 1967-73 is shown. Also averaging periods and % efficiency increases giving best correlations (r^2) are shown.

Area	Standard	MSY		Adjusted effort in each year							Best r^2		r^2	% Effort reduction from 1973 level to MSY Level
		Catch tons	Effort	1967	1968	1969	1970	1971	1972	1973	Averaging Periods	% increases in Efficiency		
Subarea 2 +Division 3K	Spain-OT c/hr	398,000	275,000 hours	271,100	394,100	434,900	494,300	487,000	604,200	431,400	7	2	0.8826	-30%
	901-1800 tons	378,000	25,000 DF	32,900	43,500	42,500	37,000	40,300	58,000	48,900	8	4	0.9704	-59%
	>1,800 tons	375,000	37,000 DF	42,900	55,800	54,900	48,100	56,400	55,300	52,500	7	11	0.9161	-30
3LNOP	151-500 tons	590,000	85,000 DF	107,800	112,900	107,500	101,600	115,800	100,000	86,600	4	3	0.8678	- 2%
	901-1800 tons	525,000	40,000 DF	45,100	46,800	54,300	61,900	64,500	68,900	52,200	7	2	0.8400	-23%

Fig. 12. Yield curves for total groundfish resource using averaging period of 7 years for effort and a constant increase in efficiency of 2% per year which produced highest r^2.

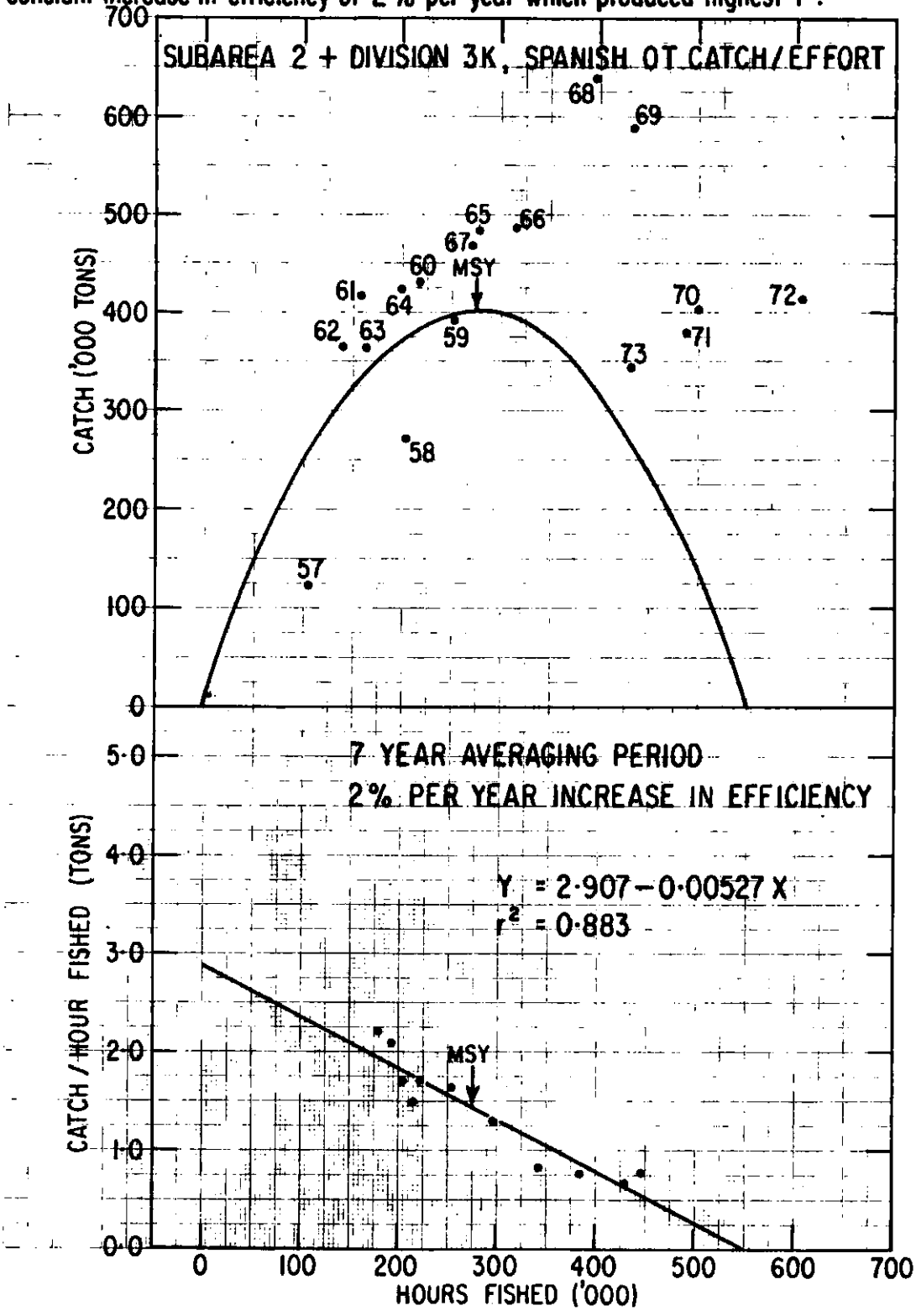

Fig. 13. Yield curves for total groundfish resource using averaging period of 4 years for effort and a constant increase in efficiency of 3% per year which produced highest r^2.